

RADIOCHEMICAL DETERMINATIONS FOR
TAILINGS REFERENCE MATERIALS

Final Report
by
Monenco Analytical Laboratories

Work on this project was conducted under the auspices
of the Canada Centre for Mineral & Energy Technology,
Energy, Mines and Resources, Canada

DSS File Number: 15SQ.23440-2-9145-4
DSS Contract Serial Number: OSQ82-00185
CANMET Scientific Authority Dr. C.W. Smith

AUG 19 1983
MICROMEDIA

9pp

TABLE OF CONTENTS

	Page
1.0 INTRODUCTION	1
2.0 ANALYTICAL PROCEDURES	1
2.01 ^{226}Ra	1
2.02 ^{228}Ra	1
2.03 ^{228}Th , ^{230}Th , ^{232}Th	1
2.04 ^{210}Po	2
2.05 ^{210}Pb	2
2.06 Reference Standards	2
3.0 ANALYTICAL RESULTS	3
4.0 BIBLIOGRAPHY	6

TABLES

TABLE 1	Activities in units of pCi/gram	4
TABLE 2	Activities in units of BQ/gram	5

1.0 INTRODUCTION

This work was undertaken to measure the activities of various radio-nuclides in each of the five Tailings Reference Materials supplied by CANMET. They were identified as UTS-1, UTS-2, UTS-3, UTS-4 and UTS-5. All analyses reported herein were performed by Dr. N. Chiu, Dr. J. Dean and Ms. I. Stromar.

2.0 ANALYTICAL PROCEDURES

All samples were analysed as received. Each was analysed four times using exactly two gram aliquots for radiums and thoriums, and one gram aliquots for polonium and lead.

2.01 ^{226}Ra

The sample was fused with KF-pyrosulfate flux and dissolved in dilute HCl⁽¹⁾. Lead nitrate was added to precipitate lead sulfate, which was then dissolved in hot DTPA. ^{226}Ra and ^{228}Ra were coprecipitated with barium sulfate from the DTPA by lowering the pH to 4.5^(2,3,4). The barium sulfate was filtered on a 0.45 μm membrane filter for high resolution alpha spectrometry to determine the activity of ^{226}Ra . The recovery was determined by the gamma counting of ^{133}Ba tracer added initially.

2.02 ^{228}Ra

The barium sulfate precipitate obtained in 2.01 above, after at least two days, was dissolved in hot DTPA. ^{228}Ac , a beta emitting daughter of ^{228}Ra was extracted into a 15% solution of bis(2-ethylhexyl) phosphoric acid/hexanes, and coprecipitated with lanthanum oxalate⁽⁵⁾. The latter was filtered on a 0.45 μm membrane filter for beta counting to determine the activity of ^{228}Ac which was then related to ^{228}Ra .

2.03 ^{228}Th , ^{230}Th and ^{232}Th

After barium sulfate was filtered, the supernate was split into two equal portions, to one was added a known amount of ^{228}Th . Both portions were then extracted with a solution of 5% bis(2-ethylhexyl) phosphoric acid hexanes⁽⁵⁾. The thorium isotopes were coprecipitated

with cerous hydroxide⁽⁶⁾ and filtered on a 0.1 μ m membrane filter for high resolution alpha spectrometry to determine the activities of ^{228}Th , ^{230}Th and ^{232}Th .

2.04 ^{210}Po

The sample was dissolved in a mixture of $\text{HF-HClO}_4\text{-HNO}_3$. Polonium was isolated by coprecipitating with lead sulfide. The latter was dissolved in 0.5N HCl and polonium deposited on a nickel disc⁽⁷⁾. High resolution alpha spectrometry was used to determine the activities of ^{210}Po and the tracer, ^{208}Po .

2.05 ^{210}Pb

The sample was dissolved in $\text{HF-HClO}_4\text{-HNO}_3$ and ^{210}Bi , a beta emitting daughter of ^{210}Pb , was extracted with a solution of 0.1% diethylammonium diethyldithiocarbamate/chloroform. ^{210}Bi was then precipitated as BiOCl and filtered on a 0.45 μ m membrane filter for beta counting⁽²⁾.

2.06 Reference Standards

The reference standards used are shown in the table below:

<u>Isotope</u>	<u>Source</u>	<u>Uncertainty</u>
^{226}Ra	NBS #4957	$\pm 1.8\%$
^{228}Th	Amersham 58/52/8	$\pm 3.5\%$
^{210}Pb	Amersham 58/40/17	$\pm 2.5\%$
^{232}Th	$\text{Th}(\text{NO}_3)_2\cdot 4\text{H}_2\text{O}$	$\pm 3.5\%$

3.0 ANALYTICAL RESULTS

The analytical results are tabulated in Tables 1 and 2. Table 1 expresses the results in units of pCi/gram and Table 2 expresses the results in units of BQ/gram.

TABLE I
Activities in units of pCi/g

Sample Description	212Th Series				230Th Series				235U Series	
	232Th	228Ra	228Th	230Th	226Ra	210Pb	210Po	210Pa		
UTS-1	I	0.58±0.03	0.74±0.07	0.64±0.05	3.52±0.07	4.03±0.07	3.00±0.07	2.8±0.4	0.21±0.02	
	II	0.82±0.05	0.92±0.07	0.67±0.04	4.81±0.15	3.81±0.06	3.03±0.07	2.9±0.7	0.23±0.02	
	III	0.61±0.03	0.74±0.07	0.67±0.04	3.52±0.07	3.42±0.05	3.18±0.07	2.8±0.2	0.20±0.02	
	IV	0.93±0.06	0.63±0.07	0.92±0.06	5.37±0.07	3.59±0.07	3.00±0.07	2.8±0.2	0.18±0.02	
	Average±1σ	0.74±0.15	0.74±0.11	0.74±0.15	4.39±0.9	3.7±0.3	3.03±0.07	2.8±0.1	0.21±0.03	
UTS-2	I	0.57±0.04	1.07±0.11	0.85±0.06	5.84±0.15	6.36±0.11	4.40±0.11	4.2±0.3	0.30±0.03	
	II	0.65±0.01	1.11±0.11	0.81±0.01	3.57±0.01	4.91±0.06	4.44±0.11	4.3±0.3	0.37±0.03	
	III	1.20±0.05	1.26±0.11	1.27±0.05	5.96±0.11	4.74±0.07	4.22±0.11	3.66±0.15	0.51±0.04	
	IV	0.83±0.06	1.15±0.11	1.18±0.07	4.70±0.15	4.55±0.07	4.29±0.11	4.5±0.6	0.31±0.03	
	Average±1σ	0.81±0.3	1.15±0.07	1.0±0.2	5.0±1.1	5.1±0.8	4.33±0.11	4.1±0.4	0.37±0.11	
UTS-3	I	0.15±0.02	N.A.	0.13±0.03	11.4±0.2	12.95±0.11	11.5±0.2	11.7±0.6	0.54±0.06	
	II	0.16±0.02	N.A.	0.16±0.03	12.1±0.2	13.95±0.11	12.1±0.2	10.1±0.5	0.78±0.06	
	III	0.22±0.02	N.A.	0.23±0.01	11.9±0.1	13.36±0.15	12.3±0.2	11.8±2.2	0.61±0.05	
	IV	0.10±0.04	N.A.	0.13±0.03	12.2±0.1	14.32±0.15	13.2±0.2	10.9±0.7	0.85±0.07	
	Average±1σ	0.16±0.05	N.A.	0.16±0.04	11.9±0.7	13.6±0.6	12.3±0.7	11.1±0.8	0.70±0.15	
UTS-4	I	0.40±0.03	N.A.	0.22±0.02	40.8±0.3	37.1±0.3	33.0±0.3	23.5±1.2	2.2±0.2	
	II	0.56±0.04	N.A.	0.27±0.03	42.7±0.4	40.0±0.3	30.7±0.3	25.4±1.1	2.3±0.2	
	III	0.73±0.04	N.A.	0.19±0.02	36.6±0.3	38.7±0.4	32.0±0.3	23.0±1.0	2.1±0.2	
	IV	0.48±0.04	N.A.	0.26±0.03	41.5±0.4	38.9±0.4	33.7±0.3	24.5±1.4	2.8±0.2	
	Average±1σ	0.48±0.07	N.A.	0.23±0.04	40±3	39.7±1.2	32.4±1.3	24.1±1.1	2.4±0.2	
UTS-5	I	2.07±0.06	2.2±0.2	1.97±0.06	14.6±0.2	13.91±0.11	13.4±0.2	11.3±0.5	0.57±0.02	
	II	2.40±0.07	2.2±0.2	2.40±0.07	14.8±0.2	14.21±0.11	13.9±0.2	10.4±0.4	0.56±0.02	
	III	1.92±0.07	2.1±0.2	2.04±0.07	14.8±0.2	14.69±0.07	13.8±0.2	11.5±0.6	0.64±0.02	
	IV	1.85±0.07	2.6±0.2	1.85±0.07	14.1±0.2	15.28±0.11	14.8±0.2	4.2±0.5	0.53±0.02	
	Average±1σ	2.1±0.3	2.2±0.2	2.1±0.2	14.5±0.4	14.5±0.6	14.0±0.6	11.1±0.4	0.57±0.04	

TABLE 2
Activities in units of Bq/g

Sample Description	^{235}U Series			^{238}U Series			^{232}Th Series			^{235}U Series	
	^{235}U	^{234}Pa	^{234}Th	^{238}U	^{234}Th	^{230}Th	^{234}Pa	^{234}Th	^{230}Th	^{234}Pa	^{234}Th
UTS-1	I	15.6±0.9	20±2	17.4±1.3	95 ± 2	109 ± 2	81± 2	75±10	6.3±0.6	231Pa	231Pa
	II	22.1±1.6	25±2	18.0±1.0	130 ± 4	103.0± 1.5	82± 2	79±18	6.3±0.6		
	III	16.4±0.9	20±2	18.2±1.0	95 ± 2	92.4± 1.4	86± 2	77± 5	5.3±0.5		
	IV	25.0±1.5	17±2	25.0±1.6	145 ± 2	97 ± 2	81± 2	75± 3	4.8±0.5		
	Average±1σ	20 ± 4	20±3	20 ± 4	116 ± 25	100 ± 7	82± 2	77± 2	5.7±0.8		
UTS-2	I	15.3±1.0	29±3	22.9±1.5	158 ± 4	172 ± 3	119± 3	113± 7	8.2±0.8		
	II	17.5±0.3	30±3	22.0±0.3	96.5± 0.3	132.7± 1.5	120± 3	115± 8	10.0±0.8		
	III	32.5±1.3	34±3	34.4±1.3	161 ± 3	128 ± 2	114± 3	39± 4	15.3±1.0		
	IV	22.4±1.6	31±2	32.0±1.9	127 ± 4	123 ± 2	116± 3	121±15	8.3±0.8		
	Average±1σ	22 ± 8	31±2	28 ± 6	136 ± 30	139 ± 22	117± 3	111±11	10 ± 3		
UTS-3	I	4.1±0.7	N.A.	3.6±0.7	309 ± 6	350 ± 3	310± 5	316±15	14.6±1.5		
	II	4.3±0.7	N.A.	4.4±0.7	326 ± 5	377 ± 3	328± 5	272±13	21.2±1.5		
	III	6.0±0.2	N.A.	6.2±0.2	322 ± 2	361 ± 4	333± 5	320±59	16.5±1.4		
	IV	2.7±0.5	N.A.	3.6±0.7	331 ± 4	387 ± 4	357± 5	294±18	23.1±1.9		
	Average±1σ	4.3±1.4	-	4.4±1.2	332 ±18	369 ±16	332±19	300±22	19 ± 4		
UTS-4	I	10.9±0.7	N.A.	5.9±0.5	1102 ± 7	1003 ± 7	892± 8	635±32	60 ± 5		
	II	15.1±1.2	N.A.	7.3±0.8	1154 ±11	1081 ± 9	831± 8	686±31	62 ± 4		
	III	19.7±1.1	N.A.	5.2±0.6	988 ± 9	1045 ±11	864± 8	621±28	58 ± 4		
	IV	13.0±1.0	N.A.	6.9±0.7	1122 ±10	1052 ±11	912± 8	662±39	75 ± 5		
	Average±1σ	13.2±1.8	N.A.	6.3±1.0	1092 ±72	1045 ±32	875±35	651±29	64 ± 4		
UTS-5	I	56.0±1.6	59±6	53.2±1.6	396 ± 4	376 ± 3	363± 5	305±13	15.3±0.5		
	II	65 ± 2	59±5	65 ± 2	400 ± 4	384 ± 3	375± 5	282±11	15.1±0.5		
	III	52 ± 2	57±6	55 ± 2	399 ± 4	397 ± 2	372± 5	310±16	17.3±0.6		
	IV	50 ± 2	69±6	50 ± 2	381 ± 6	413 ± 3	400± 6	303±13	14.4±0.5		
	Average±1σ	56 ± 7	61±5	56 ± 6	392 ±10	392 ±16	378±16	300±12	15.5±1.2		

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DISCLOSURE CERTIFICATION

Contract File Number: 15Sq.23440-2-9145-4

Contract Serial Number: OSQ82-00185

We certify that there are no disclosures to submit
under the above referenced contract, referred to in
Section 4 of DSS 1036.

Signature

Ishu Dean

Name

general manager

Official Title